INTER-DISCIPLINARY SYNERGY FOR INNOVATIVE TECHNOLOGIES

Pediatric Ruthenium Brachytherapy Plaques for Eye Cancer Treatment

Ramakant

Ruthenium Brachytherapy (RuBy) plaques of two different configurations (Round and Notched) developed earlier are being used for the treatment of eye cancers in seven Indian hospitals. In addition, development of paediatric plaque has been completed and it will be dedicated to the nation shortly for the treatment of retinoblastoma, which is prevalent in eye cancer of children below 4 years of age. Development of paediatric plaque was taken up based on the demand from RP Centre of AIIMS, Delhi.

The Paediatric RuBy plaque is a sealed source (silver material with 99.9% purity, Grade 999 of IS2112), bearing ^{106}Ru radioisotope as a radiation source. ^{106}Ru is electroplated on a flat circular disc (with 9.55 mm diameter and 0.2 mm thickness), which is then sandwiched in between two circular silver discs (with 0.9 mm and 0.1 mm thicknesses) and sealed by a brazing process. Fig.1 shows the construction features along with a photograph of the finished plaque.

Major challenges faced during the development include shaping the smaller sized product in conformity with children's eye configuration, and fabrication meeting the stringent specifications stipulated by AERB Safety Standard NO. AERB/SS/3 (Rev. 1). The overall plaque is very thin (1 mm), lightweight, easy to handle by the doctors, and comfortable for the paediatric patient. Each year, about 1000 retinoblastoma cases are reported in India. These children can directly benefit from this development.

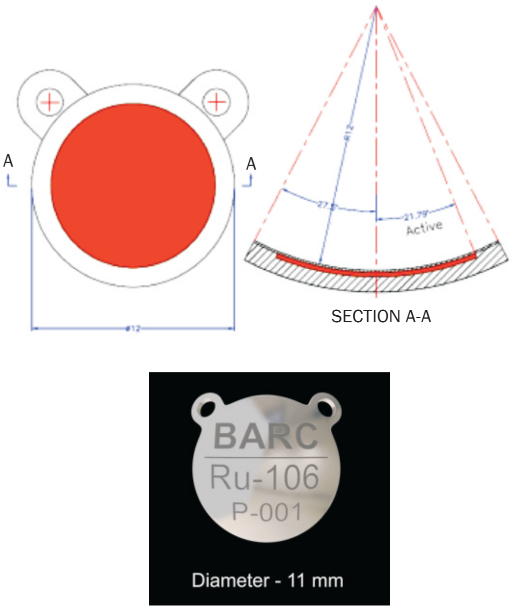

Fig.1: Construction features (Top) and photograph (Below) of the paediatric RuBy plaque.

Radiation Resistant Nuclear Battery using Ru-106 source

C. P. Kaushik

A radiation-resistant nuclear battery was demonstrated, jointly by Physics Group and Nuclear Recycle Group, utilizing the principles of beta-photovoltaic, wherein high beta energy of an electro deposited ^{106}Ru (recovered from high-level liquid waste) source is allowed to fall on a scintillator (indigenously grown Ce-doped $Gd_3Ga_3Al_2O_{12}$ by TPD), and the generated photons are converted to electricity using a photovoltaic device. Performance of the radiation resistant battery (beta-photovoltaic) was compared with that of a beta voltaic battery (see Fig.1). Long term radiation stability test carried out revealed no significant reduction in the output of the beta-photovoltaic device (Fig.2).

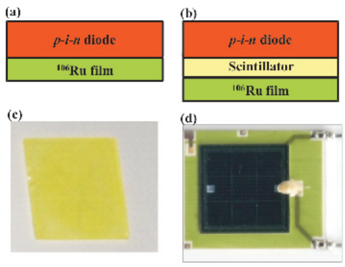

Fig.1: Battery configurations: (a) betavoltaic (b) beta-photovoltaic (c) Ce-GGAG scintillator (d) p-i-n diode.

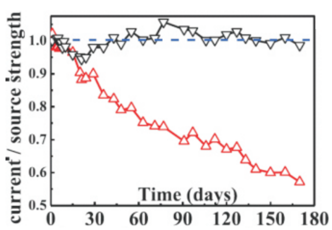

Fig.2: Current-voltage characteristics of betavoltaic (red) and beta-photovoltaic batteries (black).

Radioisotope based Thermoelectric Generator

C. P. Kaushik

BARC has indigenously built a Radioisotope Thermoelectric Generator (RTG) using minor actinide based sealed sources and bismuth telluride based thermoelectric legs(Fig.1). The device converts decay heat produced by the radioisotope into electricity through *Seebeck* effect. By virtue of having no moving parts, RTG offers high reliability with long service life, and hence it is an ideal power source for remote applications. Proof of concept for applications of RTG in remote sensing and remote surveillance was demonstrated successfully. This demonstration suggests its utility as a power source in the future deep space mission of the Department of Space.

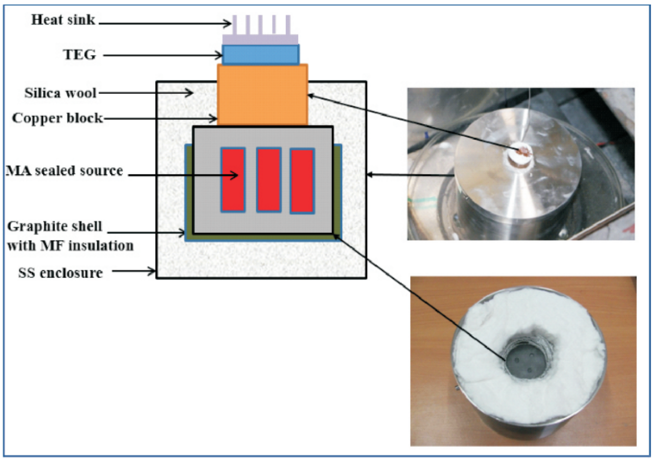

Fig.1: RTG based on MA sealed sources used for demonstration.

Technology Transfer for Bulk Production of T2EHDGA

C. P. Kaushik

The solvent, N, N, N', N'- Tetra-2-ethylhexyl-diglycolamide (T2EHDGA) is a speciality extractant used for the co-extraction of trivalent lanthanides and actinides via a solvent extraction process from High-Level Liquid Waste (HLLW). This separation of minor actinides, commonly known as actinide partitioning, helps in reduction of long-term radioactive hazards of the waste. This in turn, results in a substantial reduction in the repository footprint in terms of volume and thermal load, thereby decreasing the surveillance time and cost of managing the waste significantly. The solvent T2EHDGA has been successfully deployed in two Waste Management Plants and is envisioned to be the mainstay of India's nuclear waste management programme in the years to come. Towards this, efforts have been made to develop manufacturers capable of producing the speciality extractant on a commercial scale at a reasonable cost. The in-house developed technology for the manufacturing of the solvent is therefore transferred to an Indian manufacturers under BARC technology transfer scheme on February 14th 2022. The event is marked as a first step towards self-relience and Atmanirbhar Bharat.

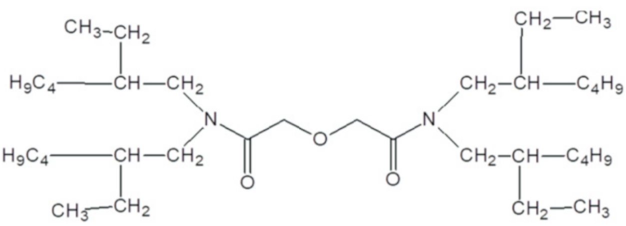

Fig.1: Chemical structure of T2EHDGA.

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